

Summary

- As a control theorist and applied mathematician by training, **I am interested** to understand and solve current problems in **sampling, stochastic control, reinforcement learning, and optimization through the lens of optimal control and filtering**.
- My current research** focuses on **using interacting particle systems to construct sampling based algorithms for stochastic optimal control and reinforcement learning**.
- My background is in stochastic optimal control and filtering, stochastic differential equations, reinforcement learning, optimal transport and differential geometry.

Education

Ph.D. in Mechanical Engineering, University of Illinois Urbana-Champaign (GPA 4.0/4.0)

Jan. 2021 - present

- Advised by Prof. Prashant Mehta
- Awarded the prestigious Grainger Engineering Graduate Fellowship

B.Tech. and M.Tech., Indian Institute of Technology Bombay, India (GPA 9.44/10)

Aug. 2015 - July 2020

- Interdisciplinary dual degree with B.Tech. in Mechanical Engineering, and M.Tech. in Systems and Control Engineering
- Best student paper award at the 29th AAS/AIAA Space-Flight Mechanics Meeting, 2019 for internship work with Prof. Kamesh Subbarao.
- Received Undergraduate Research Award for exceptional contribution to research with Prof. Arpita Sinha

Publications

During PhD

- Anant A. Joshi**, Saviz Mowlavi, Mouhacine Benosman, “A Dual Ensemble Kalman Filter Approach to Robust Control of Nonlinear Systems: An Application to Partial Differential Equations”, accepted to IEEE Conference on Decision and Control (CDC), 2025
- Anant A. Joshi**, Amirhossein Taghvaei, Prashant G. Mehta, “Error Analysis of Sampling Algorithms for Approximating Stochastic Optimal Control”, accepted to IEEE Conference on Decision and Control (CDC), 2025
- Anant A. Joshi**, Heng-Sheng Chang, Amirhossein Taghvaei, Prashant G. Mehta, Sean P. Meyn, “Interacting Particle Systems for Fast Linear Quadratic RL”, Learning for Dynamics & Control Conference (L4DC), 2024
- Anant A. Joshi**, Amirhossein Taghvaei, Prashant G. Mehta, Sean P. Meyn, “Dual Ensemble Kalman Filter for Stochastic Optimal Control”, IEEE Conference on Decision and Control (CDC), 2024
- Anant A. Joshi**, Amirhossein Taghvaei, Prashant G. Mehta, Sean P. Meyn, “Controlled interacting particle algorithms for simulation-based reinforcement learning”, Systems & Control Letters, 2022
- Jin W. Kim, **Anant A. Joshi**, Prashant G. Mehta, “Backward map for filter stability analysis”, IEEE Conference on Decision and Control (CDC), 2024
- Pulkit Katdare, **Anant A. Joshi**, Katherine Driggs-Campbell, “Towards Provable Log Density Policy Gradient”, Transactions on Machine Learning Research (TMLR), 2024

During Undergraduate and Masters

- Anant A. Joshi**, Debasish Chatterjee, Ravi N. Banavar, “Robust Discrete-Time Pontryagin Maximum Principle on Matrix Lie Groups”, IEEE Transactions on Automatic Control, 2021
- Anant A. Joshi**, D.H.S. Maithripala, Ravi N. Banavar, “A bundle framework for observer design on smooth manifolds with symmetry”, Journal of Geometric Mechanics, 2021
- Anant A. Joshi**, Debasish Chatterjee, Ravi N. Banavar, “Robust Discrete-Time Pontryagin Maximum Principle on Matrix Lie Groups”, IEEE Conference on Decision and Control (CDC), 2020
- Anant A. Joshi**, Kamesh Subbarao, “Uncertainty Quantification and Analysis of Dynamical Systems with Invariants”, AAS-19-368, 29th AAS/AIAA Space-Flight Mechanics Meeting, January, 2019
- Anant A. Joshi**, Maulik C. Bhatt, Arpita Sinha, “Modification of Hilbert’s Space-Filling Curve to Avoid Obstacles: A Robotic Path-Planning Strategy”, Sixth Indian Control Conference (ICC), 2019

Research Experience

Particle Systems for Simulation Based Reinforcement Learning

UIUC

RESEARCH WITH PROF. P. G. MEHTA, PROF. A. TAGHVAEI, PROF. S. P. MEYN

Jan 2021 - Dec 2024

- Considered the problem of reinforcement learning for continuous time and continuous state systems. Proposed a simulation based algorithm based on the Ensemble Kalman filter, which leverages duality between optimal control and filtering.
- Demonstrated that interacting particle systems are up to two orders of magnitude computationally efficient than competing approaches.

Sampling Algorithms for Stochastic Control (current work)

UIUC

RESEARCH WITH PROF. P. G. MEHTA AND PROF. A. TAGHVAEI

Jan 2025 - now

- Developed a sampling algorithm which utilizes an interacting particle system to numerically approximate the solution to discrete time continuous state stochastic optimal control.
- Performance of interacting particle approach is compared to importance sampling type algorithms. Analytical expressions for approximation error are derived to illustrate scaling with respect to state dimension and sample size.

Robust Discrete-Time Pontryagin Maximum Principle on Matrix Lie groups

IIT Bombay, India

MASTERS THESIS WITH PROF. R. N. BANAVAR AND PROF. D. CHATTERJEE

Aug. 2019 - Jul. 2020

- Proposed an extension of the Pontryagin maximum principle for discrete-time optimal control with bounded disturbances on matrix Lie groups.
- Verified the analytical solution via numerical simulations on $SO(2)$, the Lie Group of 2 dimensional rotations.

Lie Group Symmetry in Observer Design on Smooth Manifolds

IIT Bombay, India

RESEARCH PROJECT WITH PROF. R. N. BANAVAR AND PROF. D. H. S. MAITHRIPALA

Aug. 2018 - Jul. 2019

- Highlighted the decomposition of observer design problem into 2 smaller subsystems under Lie group symmetry and leveraged this structure to propose an observer for the total system.

Uncertainty Quantification in Dynamical Systems with Invariants

University of Texas at Arlington

RESEARCH INTERNSHIP WITH PROF. K. S. SUBBARAO

May 2018 - July 2018

- Investigated the effect of Gaussian white noise on dynamical systems that possess conserved quantities (invariants). Characterized the temporal evolution of the statistical moments of invariants. Theoretical results were verified with Monte Carlo simulation.

Application of Hilbert's Space Filling Curve to Robotic Exploration

IIT Bombay, India

RESEARCH PROJECT WITH PROF. A. SINHA

May 2017 - Mar. 2018

- Used Hilbert's space filling curve to plan a path for an autonomous agent to fully explore a given region with obstacles. Presented an online strategy, assuming no apriori knowledge of the location of obstacles to implement the path.

Skills and Coursework

COURSEWORK: Optimal Control, Stochastic Control, Real Analysis, Probability Theory, Stochastic Differential Equations, Partial Differential Equations, Optimization in Vector Spaces, Machine Learning for Signal Processing

SKILLS: Python, MATLAB, C++